The Californian Duck is coming to Europe, with a smile

The current energy landscape is changing rapidly. The expected growth of low cost photo voltaic (PV) capacity is the most important game changer. In California, this development has sparked an increasing awareness about the suitability of the current electricity grid and grid management requirements when impacted by a massive use of PV. The impact of a growing share of PV on the net demand (i.e. total demand minus PV and wind production) in California is illustrated by Figure 1. The resulting net demand curves are called duck curves in recent literature.

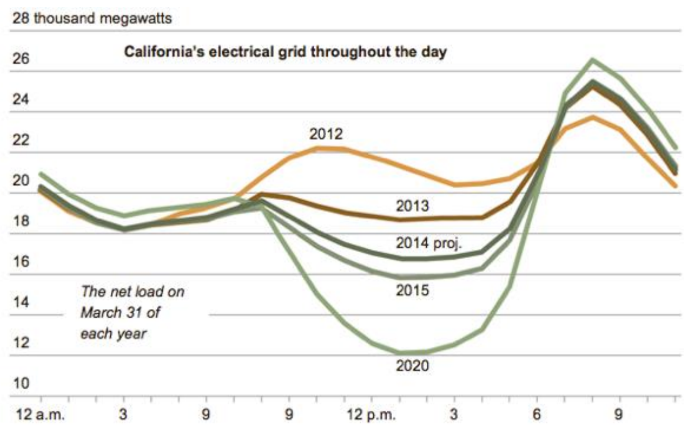

Figure 1: The Californian duck curve (source: California ISO)

Duck curves demonstrate the changing demand pattern over time when a growing capacity of PV is included. The changing shape of the curve illustrates the growth of PV production, causing a significant midday decrease in the net demand (forming the size of the belly). The head represents the expected increase in evening peak demand when PV production is gone. The combined effect of growing PV production and increasing gross demand results in a longer and steeper neck.

The duck curve illustrates that system operators and generators are required to respond much faster to keep up with the demand than in the current situation during evening peak hours. This notion has given rise to an intensive debate about the need and the application of smart grids, storage and demand response.

Given the expected substantial increase of wind and PV energy in Europe it is likely that the Californian duck comes to Europe as well and that Europe will be confronted with similar issues as California. eRisk Group has used its proprietary power model (PPSGen) to assess load curves for Northwest Europe (i.e. Germany, France, UK and the Benelux). The model combines actual hourly load data with actual weather data from various regions to assess the renewable production in these hours.

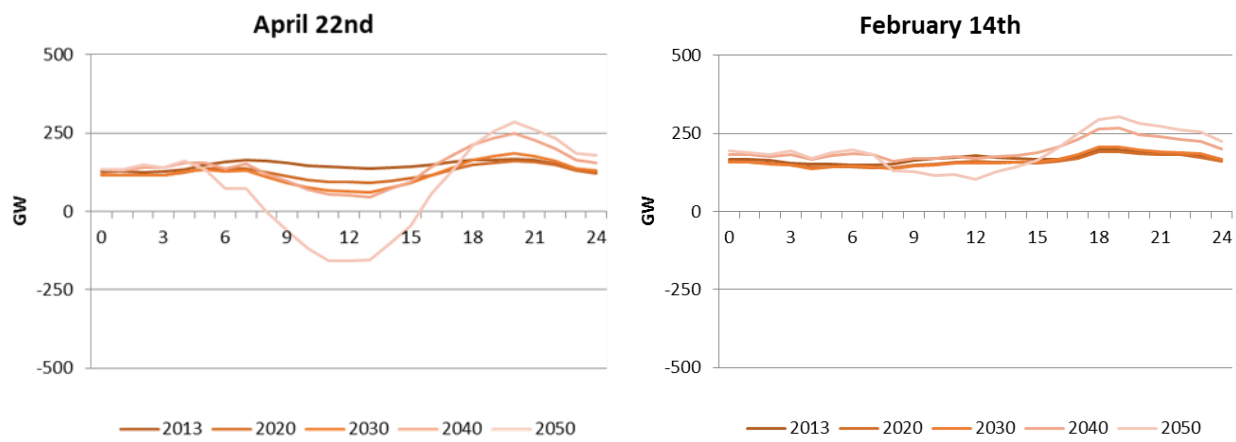

Figure 2 The Northwest European duck curve (source: eRisk Group analysis)

To evaluate the load curves for Northwest Europe a green scenario is analysed in which the installed (onshore and offshore) wind capacity increases from 120 GW in 2013 to 175 GW in 2030 and 440 GW in 2050 and in which the installed PV capacity soars from 60 GW in 2013 to about 230 GW in 2030 and over 1000 GW in 2050. This green scenario also assumes a significant increase in electricity demand as the electrification of mobility and heat demand, which will overshadow the electricity demand reduction from potential energy savings.

The graphs in Figure 2 show the resulting load curves for Northwest Europe for two days in the year. The daily demand pattern for June 22nd replicates the shape of the Californian duck curve. The belly of the Northwest European duck curves even show substantial negative net demand levels. However in the daily demand pattern for February the 14th the duck curve shape disappeared. The belly of the duck has shrunk completely because the gross demand is less affected by PV on a dark winter day. The differences between the two graphs clearly indicate the potential future issues grid operators and generators will run into. Not only will the power system have to deal with daily/weekly fluctuations but it will increasingly require a solution for seasonality as there is naturally more PV production in the summer than in the winter. The graph in Figure 3, showing the net demand on a monthly basis,

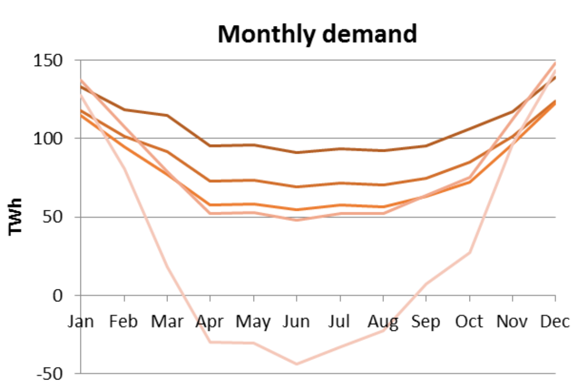

Figure 3 Annual net demand curve (source: eRisk Group analysis)

illustrates this further. An increasing PV capacity will ultimately result in a situation where the production during the summer months is higher than demand during these months.

So not only will the Northwest European electricity market be confronted with a Californian duck curve, but it will come with a Northwest European smile curve as well!

Research into European duck curves also resulted in finding another phenomenon as well. The curves are mostly present during spring and autumn, during summer days the head of the duck often disappears as a result of a combination of longer daylight hours, a lower evening peak and wind production as illustrated by figure 4 (click here for an overview of all 365 curves of the year).

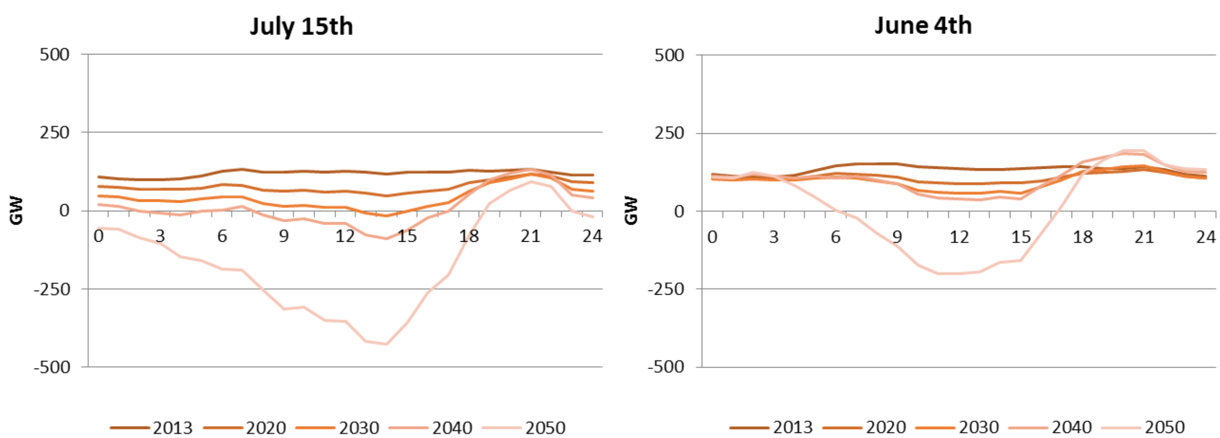

Figure 4 Northwest European demand on a day in July and June

Growth of PV capacity leads to changes of load curves. During sunny summer days net demand can become negative, and throughout the year, net demand during the summer is significantly lower than in the winter. Both developments pose significant challenges to the future energy system. Challenges which need to be addressed with appropriate market design, intelligent grids capable of facilitating demand response technologies, and storage options for both intraday (for example by efficiently using electric cars) and seasonal (e.g. with power to gas technologies).